THE MATTAGAMI RIVER

A PRELIMINARY WATER QUALITY ASSESSMENT

VOLUME ONE

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THE MATTAGAMI RIVER

- A PRELIMINARY WATER QUALITY ASSESSMENT;

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1.0 SUMMARY

A survey was initiated in August 1977, to investigate the effects upon water quality of the Mattagami River caused by the operation of a Kraft pulp mill at Smooth Rock Falls.

Information regarding the size and general description of the Mattagami River Basin is offered.

The work of previous investigators is reviewed. In 1972 a preliminary survey performed by the Ontario Water Resources Commission was inconclusive. This study merely recommended that detailed work be carried out at a later date. A study, under the auspices of the Federal Government, was undertaken in 1975 and 1976. This survey was mainly a biological study with certain water chemistry aspects investigated as well. In an invertebrate behavioural study incorporated into this work some interesting observations regarding the setting up of micro-environments by certain species in order to maintain localized aerobic conditions are noted. Certain areas of the work remained inconclusive however, due to unstable effluent discharge

conditions, caused by the 1975 pulp and paper industry strike which closed the mill at Smooth Rock Falls during a portion of the work period.

Ambient water quality within the watercourse is established by reviewing monitoring records and by in-field studies. Average conditions during the study period are reported to be: temperature 18^{o}C, Dissolved Oxygen 7.6 mg/l (79% saturation) and Conductivity 138 uMHO/cm^{2}.

Physical observations made during the August 1977 survey are presented. The difficulties regarding user/resource conflicts due to boom logs blocking the river upstream of the mill are mentioned. The most noteable visual observations immediately below the mill (i.e. foaming) are discussed. The occurrence of deposits of bark debris, bark mats and sightings of degassing areas are reported. The most pronounced accumulations of bark debris appears to be in the reach from Mile +19 - +27. The occurrence of vigorous degassing zones in the area of Mile +6 are noted.

Data describing the discharge loads of B.O.D.5, C.O.D., Dissolved Solids, Suspended Solids and Total Solids are provided. The mill discharged B.O.D.5, Dissolved Solids and Suspended Solids at rates of; 11.2 tons/day, 64.5 tons/day and 3.9 tons/day; respectively during the study period. A comparison of 'historic' reported discharges from this mill and those of August 1977 is presented. Relatively low loads from the mill were experienced during the surveillance period.

Dissolved oxygen concentrations were measured throughout the study area. Data show that the Dissolved Oxygen concentration is significantly depressed adjacent to and downstream of the pulp mill. Dissolved Oxygen levels sag to 4.3 mg/l (47% saturation) and recover only partially (6.5 mg/l at Mile +27) downstream of the mill.

The effect of mill discharges upon river water pH is discussed. The ambient conditions were pH 7.7. Below the mill this dropped to pH 7.4-7.5. The effluents discharged during the study period averaged pH 5.4.

Basic water chemistry data are presented. All parameters showed a marked increase in concentration after the confluence of mill effluent. $B.O.D._5$ increased from an ambient condition of 1.4 mg/l to 4.0 mg/l adjacent the plant outfall. Sodium concentration above the mill is reported to have been 1 mg/l; this level was found to increase to 10 mg/l downstream of the mill. Conductivity measurements indicate a significant increase of dissolved solids materials below the pulp mill.

The study points out that the effects of the pulp mill operated by the Abitibi Paper Company Ltd. at Smooth Rock Falls are quite apparent. It is further suggested that the 1977 survey was not complete in that some 30 miles of river; downstream of Poplar Rapids; was not included. Due to the occurence of major settling zones just prior to Poplar Rapids it is suggested that substantial settling areas may exist downstream of this obstacle. A complete investigation; to include the entire length of the river from Smooth Rock Falls to the Little Long Reservoir is recommended.

2.0 INTRODUCTION

The pulp and paper industry is a major manufacturing sector within the Canadian economy. Total production of pulp and paperboard products in 1973 is estimated to have been 24 million tons. Of this total Ontario mills accounted for some 5.4 million tons which is greater than 22% of the national production. (1)

As well as being a major component within the economy of the nation the pulp and paper industry is a substantial consumer of both capital and non-capital commodities. The industry in Canada used approximately 554 'billion' gallons (U.S.) of process waters in 1966. This useage is anticipated to increase to 713 'billion' gallons by 1980 and 1030 'billion' gallons (U.S.) annually by the year 2000. It is suggested that this flow represents the total flow from all of the Great Lakes for a 10 day period. (2)

The industry is also a predominant factor in aquatic pollution. In Ontario in 1973 it was

estimated that this single industry contributed 87% of the total BOD_5 and 48% of the total suspended solids discharged into Ontario's watercourses on a daily basis. Although some plants have upgraded facilities since 1973, thus allowing for some decreased waste discharge concentrations of their effluents, the absolute load of deleterious materials discharged daily within the Province of Ontario has remained about the same, due to increased production capacity. (1)

3.0 DESCRIPTION OF THE MATTAGAMI RIVER

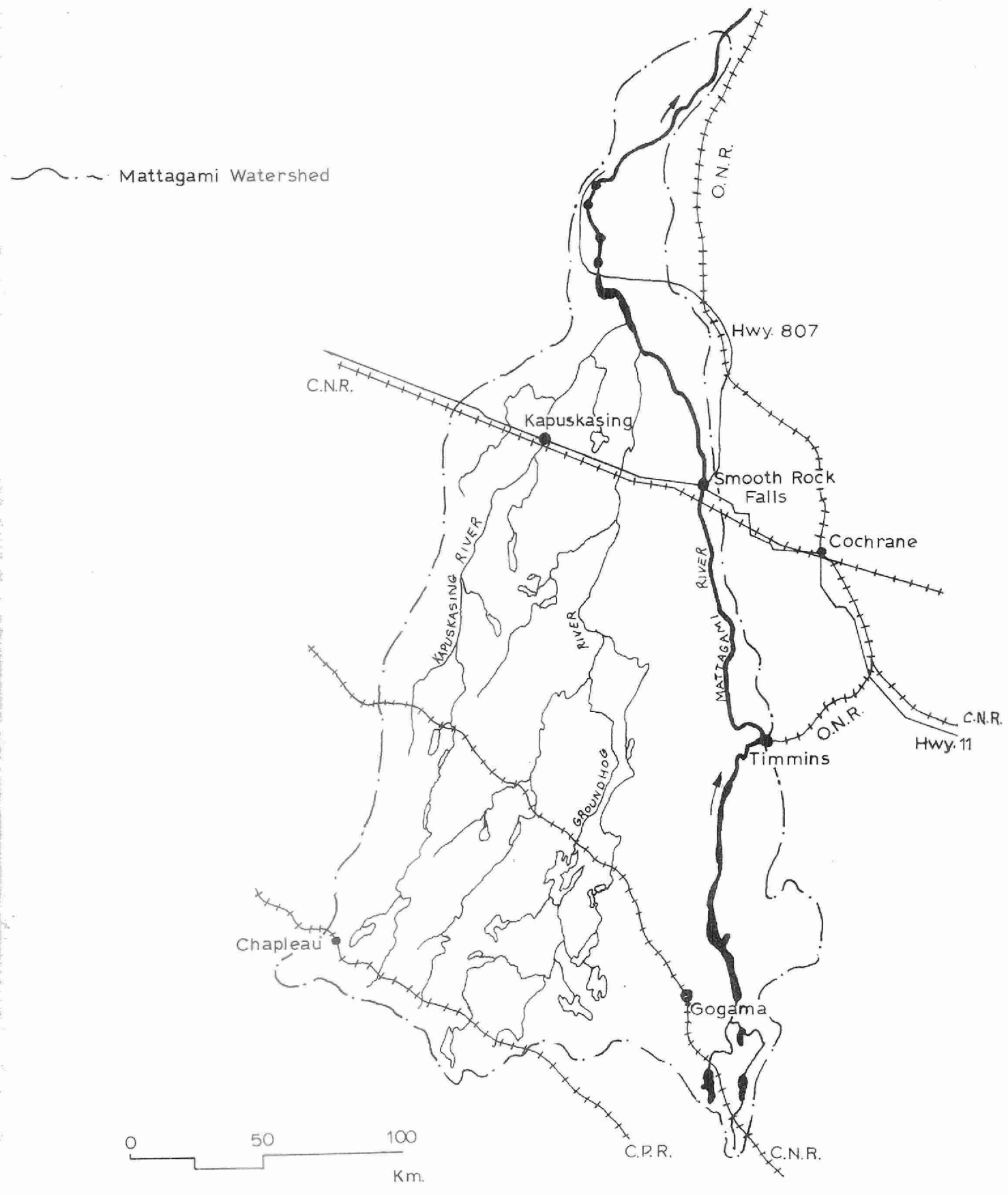
The Mattagami River originates south of the village of Gogama some 100 miles south of the City of Timmins, and flows north to join the Moose River which in turn empties into James Bay. The watershed includes several major rivers and lake systems. The Groundhog River, Kapuskasing River, Lost River and Remi River along with the Mattagami River compose the main rivers of this basin. In physical size the watershed spans some 100 miles in width and about 320 miles in length with an estimated active basin area of some 13,500 square miles. (8) The length of the Mattagami River is approximately 325 miles from south of Gogama to its mouth at the Moose River. (Figure 1)

This shallow basin exhibits mainly graded lucustrine deposits. Soils are mainly glacial gravels and sands in the southern portion, tending towards more seasonally deposited clay-type materials laying north of Timmins. The soils are termed as acidic medium to coarse till materials. Topography varies from moderately 'hilly' in the

Figure 1

MATTAGAMI RIVER WATERSHED

(Adapted from CPAR 389-1977)



southern portion to lowlands in the Moose River area at the northern extremity. (9)

The Mattagami River is controlled at several points along its length. Specifically dams at Mattagami Lake, Wawaitin Falls Generating Station (G.S.), Sandy Falls G.S. and at Lower Sturgeon G.S. control flow above Smooth Rock Falls. Below this point are power dams at Smooth Rock Falls, Little Long G.S., Smoky Falls G.S., Harmon G.S. and Kipling G.S. All facilities generating power on this river are operated under the auspices of Ontario Hydro with the exception of Smoky Falls (owned by Spruce Falls Power and Paper Co.) and the Smooth Rock Falls generating facility (owned by Abitibi Paper Co. Ltd.). In addition to generation facilities numerous water control dams are situated throughout the watershed and are controlled predominantly by Ontario Hydro.

The river ranges in depth from shallow areas of two foot depth or less to sections in the backwater areas above dams approaching thirty to forty feet in depth. River width varies from two

hundred to eight hundred feet.

Throughout the length of the Mattagami River natural reaeration zones are abundant with many rapids and riffle areas. Although the major elevation gradients have been harnessed for hydraulic power generation substantial rapids exist between Timmins and Smooth Rock Falls (Sandy Falls, Sturgeon Rapids, Loon Rapids, Davis Rapids, Yellow Falls and Island Falls). Downstream of Smooth Rock Falls this trend continues with major obstacles present at Fish Rapids, Scar Rapids, Poplar Rapids, Ledge Rapids, Katikumabi Falls and Cypress Falls. It is obvious unobstructed navigation on the watercourse is not possible due to the common occurrence of falls and rapids.

Water in this river is very highly coloured from naturally occuring constituents.

The river is a popular canoe route to James Bay. Tourists usually proceed downstream (north) from Smooth Rock Falls since log booms upstream of the Abitibi Paper Co. at this location obstruct passage for a portion of the season.

4.0 PULP MILL - SMOOTH ROCK FALLS

The Abitibi Paper Company Ltd. operates a Kraft pulp mill at Smooth Rock Falls. The construction of the mill, located adjacent the Mattagami River, was completed in 1917. This operation was a calcium based sulphite operation. Discharges from this 'chemical' process along with all effluents associated with debarking logs for the mill were sewered directly to the Mattagami River.

These practices continued until the early 1960's when the Company embarked upon a process conversion. The mill was converted to a bleached Kraft pulp mill. The Kraft mill went into production in 1965. Discharges from process streams, including debarking, were sewered directly into the Mattagami River until 1969.

In 1969, due to pressures from the Ontario Water Resources Commission, the Company constructed certain settling basin facilities. Specifically, a small island adjacent the mill outfall; and

essentially parallel the river bank was bermed-off to make a lagoon. This lagoon has since been known as the 'Foam Lagoon'. Concurrently a ravine approximately 1/3 mile northeast of the mill was developed for use as a settling basin for woodroom/screenroom discharges. This 'Bark Ravine' with about 2 hours retention time, discharged via a creek directly to the Mattagami River.

During the summer of 1974 a diffuser was installed in the 'Foam Lagoon' discharge. This allowed for discharge to enter the watercourse below the surface providing some minimizing of foaming at the mill outlet point.

In July 1976 the Company began operating a 115 foot diameter clarifier. The clarifier treats woodroom/screenroom effluents with effluent proceeding to the 'Foam Lagoon' for final discharge to the receiving stream. Suspended solids concentrations are reduced 75-90% by this treatment system.

The mill produces bleached Kraft pulp for market sales. No paper products are manufactured at this location. The mill is rated at 350 tons/

day capacity however the more normal production rate is about 300-325 tons per day.

Based upon recent Company reported data the mill presently discharges about 14.4 million U.S. Gallons per day. The discharge of $B.O.D._5$ and Suspended Solids materials are reported to be approximately 15 tons/day and 10 tons/day respectively (10). These data fall within ranges suggested as 'expected' discharges from an operation of this vintage; based upon production capacity (11). A significant reduction in discharge loads of Suspended Solids has been noted; from approximately 15 tons/day to 8 tons/day; since the start-up of the clarifier in July 1976.

5.0 PREVIOUS INVESTIGATIONS

5.1 PHYSICAL STUDY - 1970

In 1970 the Ontario Water Resources Commission; Water Resources Branch performed a preliminary survey upon the Mattagami River.

This study was implemented to determine the base data which would be necessary to perform a more detailed water quality survey and the preparation of an assimilative capacity model. This work investigated mainly physical flow parameters. Sonar soundings, width measurements and cross-sectional flow readings were taken.

Data regarding Dissolved Oxygen concentrations were not reported. No chemical sampling of the river or of the mill outfall was initiated.

Although the results of this preliminary work were not published certain observations were noted by the field investigators.

Reports of bark debris, bark and fiber mats, and degassing zones were mentioned. The occurence of several

riffle areas and rapids downstream of the mill were emphasized.

The 1970 study group recommended that the Mattagami River be considered for a detailed water quality or assimilation capacity study. The investigators went on to suggest that the entire river should be included in the investigation and indicated that aerial field support (helicopter) may be necessary to adequately provide access to certain reaches of the watercourse.

5.2 CPAR STUDY - 1975, 1976

During the summer months of 1975 and 1976 a detailed biological study was performed upon the river. (2) This study was sponsored by Environment Canada as part of the Co-operative Pollution Abatement Research (CPAR) program. This CPAR study investigated the effects of pulp mill wastes upon various aquatic communities. Certain water chemistry data supported biological conclusions to suggest various levels of aquatic impairment as a result of discharges from the pulp mill at Smooth Rock Falls. This study carefully investigated three riffle and pool stations on the Mattagami River. The Poplar Rapids River, a tributary of the Mattagami, was used as a control station. During 1976, the investigation was expanded to include two stations within the Little Long Reservoir.

In 1975 sediment samples were collected and used for laboratory studies of redox potential and loss of NO_3-N from water overlying sediment deposits. These experiments were repeated in 1976 and expanded to include a benthic invertebrate behavioural study. During the course of this study observations showed benthic impairment at stations close to the mill. This was most evident by the predominence of organisms indicative of organically enriched waters. Indications of invertebrate recovery began to be apparent some 14 miles downstream and improved with distance from the mill. No chemical evidence of impairment of water could be noted at the Little Long Reservoir.

The invertebrate behavioural study performed provided certain notable information. It was found that many species of benthic invertebrates burrowed deep into sediments which were found to have either extremely low oxygen concentrations or were anoxic with H_2S present.

' The laboratory experiment found that the experimental mayfly species burrowed into the sediments and suggested that these animals set-up a micro-environment in their burrows where constant water circulation maintains aerobic conditions. This setting-up of the aerobic micro-environments could conceivably be very important in accelerating the oxidative breakdown of wood and fibre material deposited as part of the river sediments from the mill effluent'.(2)

The 1975-1976 work is an excellent investigation of certain specific sites downstream of the mill, however some shortcomings are noted. The study is based on a small number of stations and samples which is understandable due to the difficulties regarding access to the work area. Another difficulty is that water chemistry data for 1975 are not likely to reflect the normal aquatic conditions.

A strike caused the mill to cease operations in July 1975 which lasted for a six month period (study performed September 1975). Data regarding sediment conditions for 1976 are likely fairly accurate.

6.0 WATER QUALITY SURVEY - 1977

6.1 OBJECTIVES

During the period August 16-18, 1977, a water quality survey was conducted upon the Mattagami River. This surveillance was a joint effort involving staff from the local Ministry of the Environment office in Timmins along with a Technical Support member (M.O.E.) for Northeastern Region (Sudbury).

The study was to investigate the following:

- the ambient water quality of the Mattagami River; upstream of the Abitibi Paper Company Ltd., Smooth Rock Falls.

- the physical conditions that existed in the river below the pulp mill due to past and present operations of the mill (deadheads, bark mats, bark deposits, degassing zones etc.).

- the quantities of B.O.D.$_5$, C.O.D., Dissolved and Suspended Solids, and Sodium discharged from the Abitibi Paper Company Ltd.; during the period of the surveillance.

- the Dissolved Oxygen and pH conditions that existed above and below the outfall of the mill.

- the effects upon water chemistry within the river caused by the discharge of wastes into the river by the mill.

- the occurrence and identification of invertebrates within benthic samples, in order to suggest whether impairment to the environment of aquatic communities was evident.

6.2 AMBIENT WATER QUALITY

The Ontario Ministry of the Environment has maintained a water quality monitoring network for most major watercourses since the mid-1960's. Data from yearly summaries indicate the average 'expected' concentrations of parameters which may be observed in any given month. Information describing the observed conditions in the Mattagami River at Timmins and at Smooth Rock Falls are illustrated in Table 1.

These data indicate that during the period of this surveillance the average water temperature has been 19°C. The observed ambient temperature was 18°C during the August 1977 work.

Dissolved Oxygen concentrations at Timmins averaged 7.2 mg/l or 76.5% saturation. Ambient Dissolved Oxygen concentrations observed above Smooth Rock Falls on August 16, 1977 averaged 7.6 mg/l or 79% saturation.

The monitoring station at Timmins indicated an

Table 1

Mattagami River

Ambient Water Quality

Location	Date	Water Temp. °C	Dissolved Oxygen mg/l	Dissolved Oxygen %Sat'n	B.O.D.5 uMHO/cm^2	Conductivity uMHO/cm^2
Hwy. 101 Bridge Timmins	Aug.1972(1)	19	9.0	96	1.4	102
	Aug.1973(1)	22	5.0	57	1.4	93
	Aug.1974(1)	20	7.0	76	0.8	100
	Aug.1975(1)	20	8.0	87	0.4	110
	Aug.1976(1)	14	7.0	67	0.2	97
	Average	19	7.2	77	0.84	100
Above Hwy 11 Bridge; Smooth Rock Falls	Aug.16/77(2)	18.3	7.5	79	1.8	145
		18.3	7.4	78	1.2	135
		18.2	7.8	81	1.3	134
	Average	18.3	7.6	79	1.4	138

(1) Source: Water Monitoring Data Sheet; Ont. Min. of Envir. Timmins District Summary

(2) Data collected during Aug. 1977 Water Quality Survey.

average $B.O.D._5$ concentration of 0.8 mg/l during the month of August 1972 - 1976. Conductivity of river water at Timmins averaged 100 uMHO/cm^2 during this month for the same period.

Observations of $B.O.D._5$ and of Conductivity for August 16, 1977 showed slightly higher concentrations for these parameters. Specifically concentrations of 1.4 mg/l and 134 uMHO/cm^2 were observed respectively. This difference in concentration appears to be within the standard deviation of historical data referring to this source.

6.3 PHYSICAL OBSERVATIONS OF RIVER

The surveillance area for the August 1977 study was from upstream of the pulp mill; some 4-5 miles; to 26 miles downstream, a point upstream of Poplar Rapids.

The Mattagami River is approximately 1200-1500 feet wide in the headpond of the dam at Smooth Rock Falls. Depth was measured to be up to 40 feet, in the channel. The headpond is used to store 8 foot pulpwood for use in the mill. Access is blocked between the Highway #11 bridge and the C.N.R. railway bridge; some 2½ miles; due to log booms. Upstream of the access point at Jacksonboro Landing, a boat channel provides access to upstream portions of the river. No signs of physical impairment to the river were noted above the pulp mill. Bark materials were noted to occur in all dredge samples collected adjacent the log boom. Access and aesthetic conflicts appear to be the main problems above the mill. Occasionally elevated bacterial contamination; during low flow and high river temperature situations; is noted.

Below the pulp mill the outfall of effluent is apparent both visually and by its odour. Foam was observed trailing downstream from the outlet point, even though effluent discharges below the surface which helps minimize the problem. Foam was documented to be observed up to 3 miles downstream of the mill. Some regeneration of foam occurs in rapids in the reaches nearest the pulp mill.

Within the first 2 miles downstream of the river the effects of the discharges of wastes from the pulp mill became evident. Large deposits of bark debris were obvious. Bark mats were noted floating on the surface. These mats would break-up upon contact with a solid object (boat or oar, etc.).

From Mile +2 to Mile +12, areas of degassing were common. Several of these areas are shallow 'backwater' areas where water temperatures were in the 19 - 20^{o}C range. At one location (Mile +6), degassing from bottom sediments was so vigorous that the river

crew reported being able to 'hear' this bubbling action. In this reach of the river large floating bark mats of up to 2 feet square were reported. (Figure 2)

At about Mile +8.2 a small riffle area causes a slight improvement in B.O.D.$_5$ and Dissolved Solid concentrations. Due to the shallow-rocky nature of this reach of the river few bark deposits were noted between Mile +10 and Mile +17. Sightings of large 'bark islands' were noted in slow moving sections of river in the vicinity of Mile +19. These particular deposits were mainly of bark with some other fibrous materials present. One particular deposit was some 150 feet in length and 3 feet above the waterline. (Figure 4)

The most apparent accumulations of wood debris were evident from Mile +19 to the Poplar Rapids (Mile +27). This eight mile reach of river generally is wide (400-500 feet) and shallow (5-10 feet).

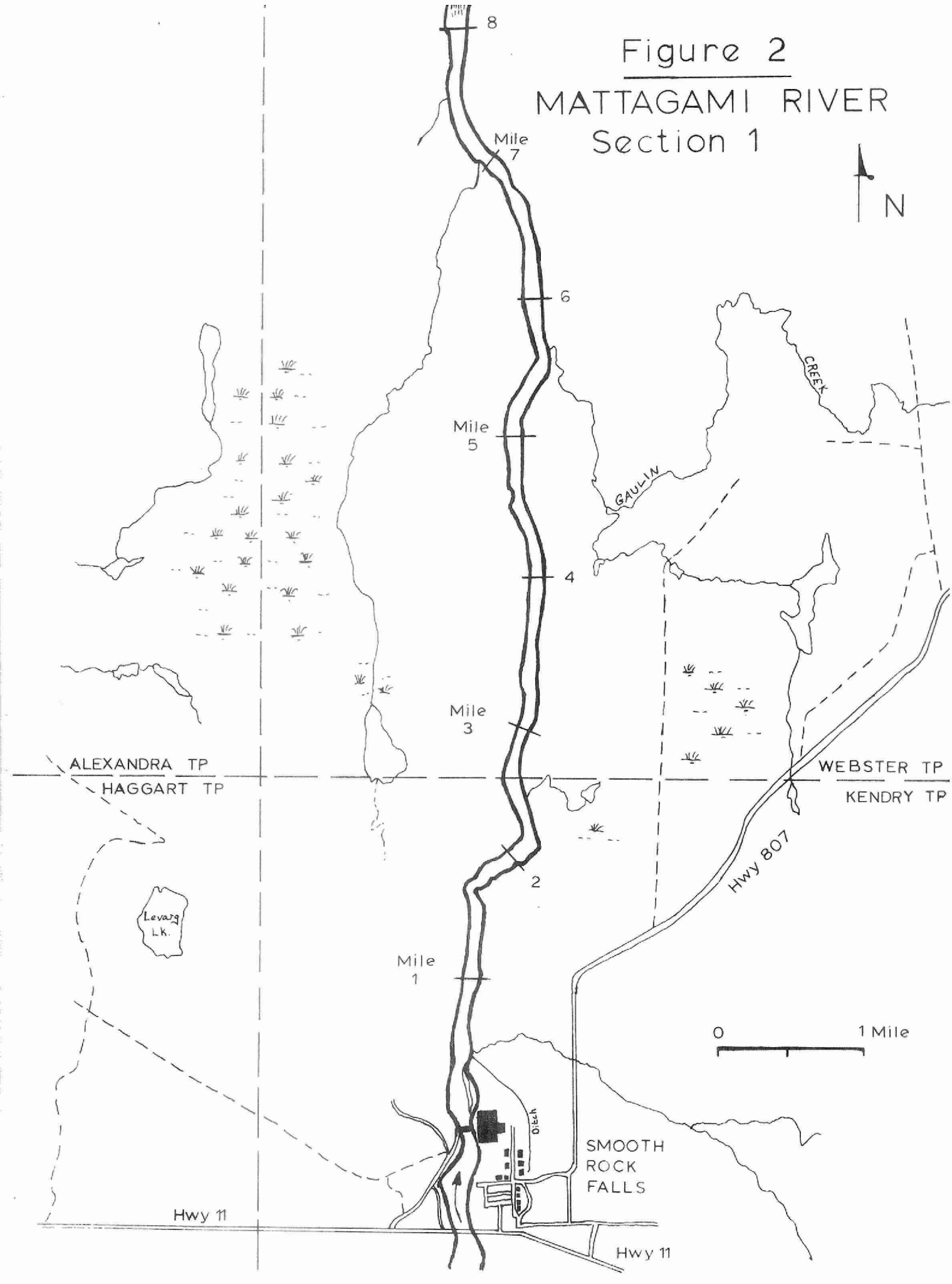


Figure 2
MATTAGAMI RIVER
Section 1
N
8
Mile 7
6
Mile 5
4
Mile 3
2
Mile 1
CREEK
GAULIN
ALEXANDRA TP
HAGGART TP
WEBSTER TP
KENDRY TP
Hwy 807
Levasq L.k.
0
1 Mile
Ditch
SMOOTH ROCK FALLS
Hwy 11
Hwy 11

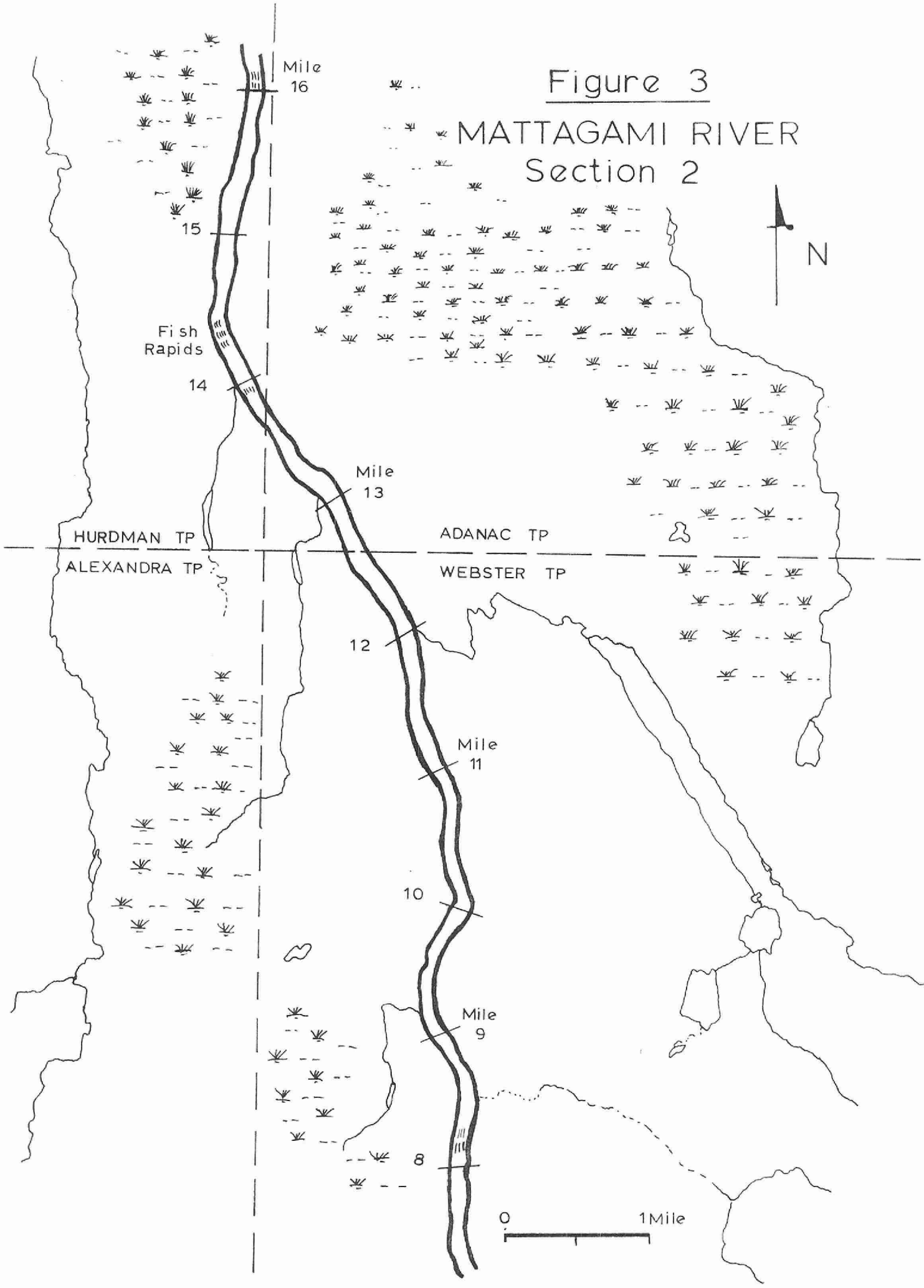


Figure 3
MATTAGAMI RIVER
Section 2
N
Mile 16
15
Fish Rapids
14
Mile 13
HURDMAN TP
ALEXANDRA TP
ADANAC TP
WEBSTER TP
12
Mile 11
10
Mile 9
8
0
1 Mile

It appears that this section is the most predominant 'settling' zone observed during the course of this investigation.

At the Mile +23 station; in the backwaters of a small island chain, a very large bark deposit was observed. This 'bark island' was reported to be 300 feet in length; 40-50 feet in maximum above-water width; and apparent some 2-4 feet above the existing waterline. The shoreline from Mile +19 to Mile +26 is littered by a variety of wood debris (bark, slivers, and fibrous materials). (Figure 4)

Due to the physical obstruction to passage caused by Poplar Rapids; the study was terminated at Mile +26. Further details regarding various physical observations reported appear in Table 2.

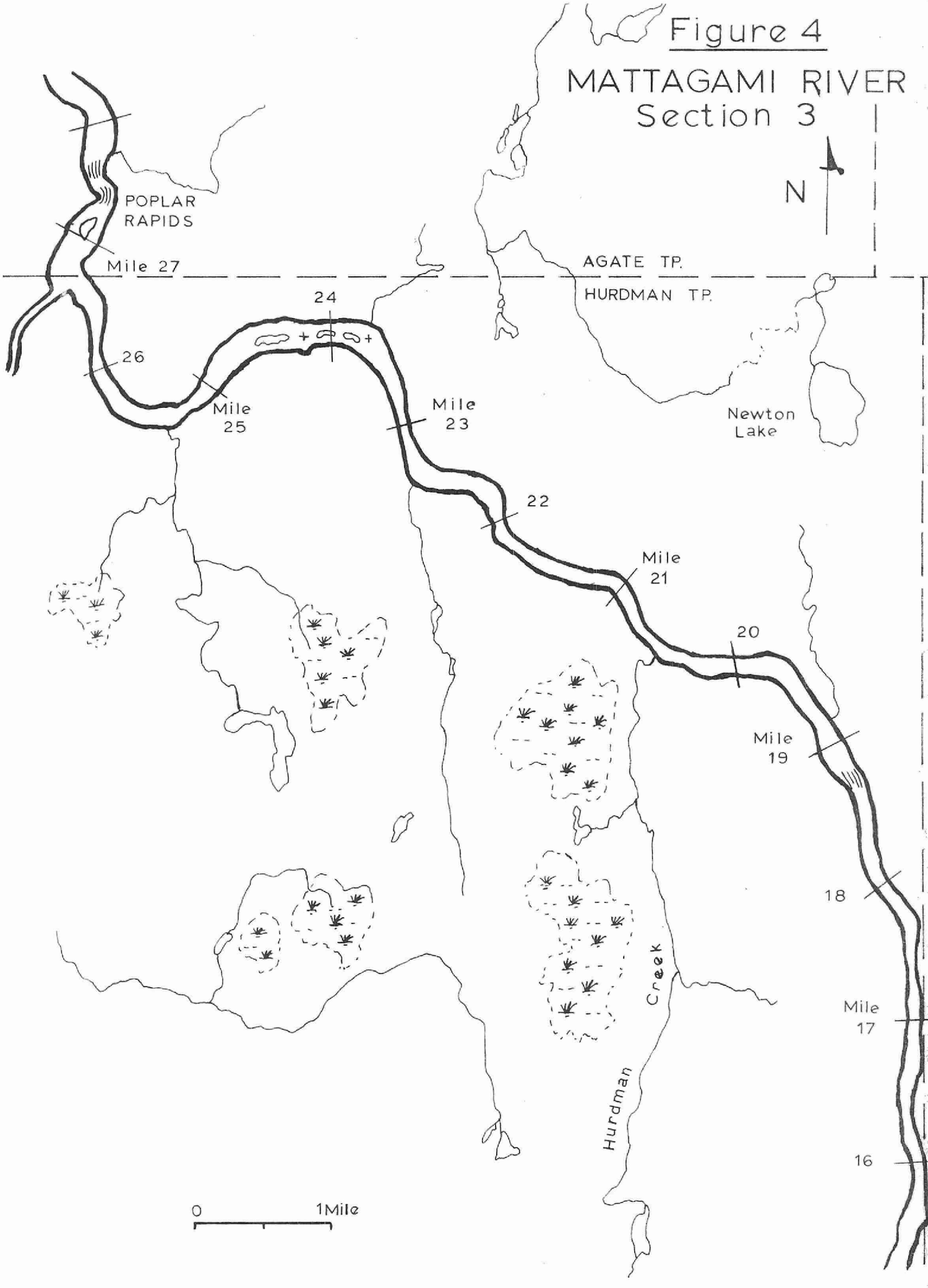


Figure 4
MATTAGAMI RIVER
Section 3
N
POPLAR
RAPIDS
Mile 27
AGATE TP.
HURDMAN TP.
24
26
Mile
25
Mile
23
Newton
Lake
22
Mile
21
20
Mile
19
18
Mile
17
16
Hurdman
Creek
0
1Mile

TABLE 2

MATTAGAMI RIVER

August 16 - 17, 1977

PHYSICAL DATA

Station #	Location from Mill(1) (miles)	Depth (feet)	Width (approx.ft.)	River Flow(2) (ft^3/sec)	Comments
1	-4	40	1500	1160	Control Sample Station - S. of Jacksonboro
2	-4	20	200	-	Muskego River
3	-5	30	1000	1160	Above boom logs
5	0	20	300	1160	Foam not apparent on mill effluent. Effluent causing warming of river water. Large bark island. Observed degassing. Floating bark mats observed.
6	+2	22	300	(3)	Many deadheads noted up to 1 mile downstream. Large bark island at mile 1.7; 150 ft. length above water 4-5 ft.
7	+4	10	300	(3)	Deadheads
8	+6	18	300	(3)	Degassing in river noted between St. 7-St.8 Deadheads,. Bark debris on banks. Excessive degassing near St. 8; could hear bubbling. Large bark mats floating (2 ft^2)

TABLE 2

MATTAGAMI RIVER (Cont'd)

August 16 - 17, 1977

PHYSICAL DATA

Station #	Location from Mill (1) (miles)	Depth (feet)	Width (approx. ft.)	River Flow (2) (ft^3/sec)	Comments
9	+8	6	400	(3)	Degassing in river. Deadheads. Bark mats. Riffle area at mile 8.2.
10	+10	12	450	(3)	Degassing in river.
11	+12	10	350	(3)	Rocky bottom. Dissolved Oxygen 4.7 ppm at 4' below surface.
12	+14	12	400	(3)	Small riffle area. D.O. makes some recovery.
13	+16	10	200	(3)	
14	+18	4	400	(3)	Slow moving section. Large bark island-150 ft. long; 3 ft. above water line below Station 14 (19 mile)
15	+20	7	300	(3)	
16	+23	4	600	(3)	Extremely wide-slow moving section. Large bark accumulations just below St. 23 (24 mile). Bark 300 ft. long; 2-3 ft. above water; 40-50 ft. width.

TABLE 2

MATTAGAMI RIVER (Cont'd)

August 16 - 17, 1977

PHYSICAL DATA

Station #	Location from Mill (1) (miles)	Depth (feet)	Width (approx.ft.)	River Flow (2) (ft^3/sec)	Comments
17	+26	12	400	(3)	Bark debris along banks from station 16-17. End of survey due to Poplar Rapids at 27 miles.

(1) Note: Location ⊖ indicates miles upstream of mill; ⊕ indicates miles downstream of mill.

(2) River flow information for Aug. 16-17, 1977 provided by Abitibi Paper Co; Tech. Dept; Smooth Rock Falls.

(3) River flow data was not collected downstream of the power dam at Smooth Rock Falls.

6.4 RIVER FLOW

The Abitibi Paper Company Ltd. operates a hydraulic power generation facility on the Mattagami River at Smooth Rock Falls.

Flow measurements are made at the powerhouse and records of flow have been maintained since the early 1920's.

A review of river flow conditions from 1967 to 1977 was initiated; these data appear in Table 3.

During the week of August 14 - 20, 1977 the river flow averaged 1160 cubic feet per second. This flow, as can be seen from Table 3, is below the average usually observed at this time of year.

TABLE 3

MATTAGAMI RIVER FLOW (1)

(ALL FLOWS IN CUBIC FEET PER SECOND)

	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	AVERAGE
January	3016	2430	2285	2345	2150	2080	2330	1995	1920	Strike	1660	2,211
February	3214	2825	2240	2215	1990	2280	2200	2190	2080	1980	1550	2,251
March	3107	3440	2690	2505	2350	2040	3550	2580	2100	2050	2530	2,631
April	13920	10665	8680	4290	5760	3270	8280	3860	3960	13315	9925	7,811
May	16700	5470	10400	9220	13330	12530	11570	13970	8930	11560	5700	10,862
June	7080	7500	5900	7605	4440	7420	5200	6650	8780	2420	2470	5,951
July	3380	6075	2890	4720	2630	3150	3640	3895	2200	1710	1830	3,284
August	3205	2415	2600	3030	1845	1880	3070	2120	Strike	1330	1200	2,270
September	2330	2465	3040	2550	1890	2030	4170	2365	"	1335	2810	2,499
October	2130	2810	3360	2505	2120	3285	2925	3545	"	1745	2080	2,650
November	3165	2210	4180	2430	2520	2355	2620	2800	"	960	-	2,582
December	2475	2040	2835	2295	2170	2110	2080	2160	"	1385	-	2,172

(1) Data from: Abitibi Paper Co. Ltd.; Smooth Rock Falls

Records of flow at powerhouse - Technical Dept.

Data are monthly averages.

6.5 PULP MILL DISCHARGES

As suggested earlier the total mill effluent from the Abitibi Paper Co. Ltd. in Smooth Rock Falls discharges from one location. This is known as the 'Foam Lagoon' outlet. All process waste streams; treated and untreated; exit to the river via this source.

The 'Foam Lagoon' outlet which exits via a collection sump allows effluent to overflow to the river through a submerged diffuser pipe. No routine composite sampling is carried out for this source. Daily samples are collected by mill staff on a 'grab sample' basis. Daily suspended solids and weekly $B.O.D._5$ analyses are performed by Abitibi Paper Co. Ltd. Results of these analyses are included in 'Monthly Effluent' Reports sent to the local Ministry of the Environment office.

During the course of the August 1977 survey, samples of effluent being discharged to the river were collected. Since no 'composite' sampling equipment was available for this task a 'grab' sampling program was used.

'Grab' samples were collected from the 'Foam Lagoon' outlet sump each hour during the afternoon of August 16, and both during the morning and afternoon of August 17, 1977.

Samples were refrigerated and shipped via courier to the Ministry of the Environment Laboratory in Toronto.

Samples were analysed for:

- B.O.D.$_5$
- C.O.D.
- Total Solids
- Suspended Solids
- Dissolved Solids
- Conductivity
- Sodium
- pH at Lab.

Results of these analyses appear in Table 4. Effluent flow data were supplied by the Abitibi Paper Co. Ltd. - Technical Department. An estimate of water input to the plant is used as an effluent discharge flow rate.

Data indicate that during the period of the study the $B.O.D._5$ concentrations averaged 199 mg/l (11.2 tons/day). The C.O.D. discharged averaged 846 mg/l (47.4 tons/day).

The discharge of Dissolved Solids and Suspended Solids averaged 1150 mg/l and 69 mg/l respectively, for the period observed. These concentrations correspond to a loading of 64.5 tons/day of Dissolved Solids and 3.9 tons/day of Suspended Solids.

The conductivity of the mill discharge ranged from 1340 - 1750 $uMHO/cm^2$ averaging 1599 $uMHO/cm^2$ during the period of this surveillance.

The sodium ion concentration averaged 278 mg/l during the investigation.

The pH of the mill discharge, upon averaging the hydronium ion concentration corresponding to the indicated pH values, yielded an arithmetic mean of pH 5.4.

Data describing the mill effluent during the period of this surveillance were compared to 'historical' effluent data for the Smooth Rock Falls mill. This comparison is illustrated in Table 5.

As can be seen the August 1977 mill effluent data compared fairly well with the observed loadings as previously reported, with the exception of Suspended Solids. Data describing the Suspended Solids loadings for the August 1977 surveillance appear well below the reported discharges for 1976 and June 1977.

It is noteworthy that the August 1977 data are well below the 'national' average of expected Suspended Solids generation for a Kraft mill of the vintage of the Smooth Rock Falls operation (August 1977 - 26 lbs/ton of pulp produced; national average 74 lbs/ton). (11)

Concern is expressed with regards to the integrity of low Suspended Solids values indicated by data for this surveillance. This operation has not installed equipment or processes substantially different than the 'average' Kraft mill yet the data indicate extremely low discharge loads. Certain difficulties with accurately monitoring effluent flow may be confirmed as the cause of these low reported values. The Company is presently evaluating a more accurate method of indicating effluent flow from the mill.

TABLE 4

ABITIBI PAPER COMPANY LTD. - SMOOTH ROCK FALLS, ONT.

August 16-17, 1977

MILL EFFLUENT

Date	Time	BOD_5 (mg/l)	BOD_5 (T/D)	COD (mg/l)	COD (T/D)	SOLIDS Total (mg/l)	SOLIDS Total (T/D)	SOLIDS Dissolved (mg/l)	SOLIDS Dissolved (T/D)	SOLIDS Suspended (mg/l	SOLIDS Suspended (T/D)	pH(3)	Conduc. ($uMHO/cm^2$)	Na (mg/l)	Flow(4) (MUSGD)
Aug.16	12:58 PM	145	8.1	750	42.0	1320	73.9	1240	69.5	80	4.5	6.8	1570	260	13.437(1)
	2:05 PM	150	8.4	750	42.0	1405	78.7	1340	75.1	65	3.6	6.5	1720	260	13.437
	2:55 PM	160	9.6	810	45.4	-	-					6.2	1750	300	13.437
Aug.17	9:00 AM	200	11.2	730	40.9	1140	63.9	1080	60.5	60	3.4	5.9	1420	230	13,437
	10:00 AM	200	11.2	800	44.8	1210	67.8	1126	63.1	84	4.7	4.4	1520	240	13.347
	11:00 PM	210	11.8	960	53.8	1385	77.6	1298	72.7	87	4.9	6.5	1670	290	13.347
	12:00 PM	230	12.9	890	49.9	1395	78.1	1332	74.6	63	3.5	6.9	1650	310	13.347
	12:55 PM	230	12.9	930	52.1	1365	76.5	1292	72.4	72	4.0	7.0	1610	290	13.347
	2:00 PM	250	14.0	980	54.9	1595	89.3	1485	83.2	111	6.2	7.6	1740	330	13.347
	2:55 PM	210	11.8	860	48.2	1380	77.3	1310	73.4	70	3.9	7.9	1340	270	13.347
Average		199	11.2	845	47.4	1355	75.9	1278	71.6	77	4.3	4.3	1599	278	13.347

(1) Tons Per Day

(2) Flow of 13.437 million U.S. Gallons/day calculated from Abitibi Paper Company Ltd. - Monthly Effluent Report; August 1977

(3) Average pH data calculated by averaging the H_3O concentration

(4) Flow in Million U.S. Gallons/day is calculated from U.S.G./min. data supplied by the Abitibi Paper Co. Ltd.

TABLE 5

PULP MILL DISCHARGE - 'HISTORICAL' DATA COMPARISON

ABITIBI PAPER COMPANY LTD. - SMOOTH ROCK FALLS

Source	B.O.D.5 (Tons/Day)	B.O.D.5 (lbs/Ton) (1) (3)	Dissolved Solids (Tons/Day)	Dissolved Solids (lbs/Ton) (3)	Suspended Solids (Ton/Day)	Suspended Solids (lbs/Ton) (3)	Flow (Mill USGD)
1976 Abitibi Paper Co. Monthly Reports	15	98	64	418	10	65	17.7 - 6(2)
1977 Industrial Survey - M.O.E.; June 1977	7	46	61	399	7	46	15.5
1977 Mattagami River Survey - M.O.E. Aug. 1977	11	72	65	424	4	26	13.4

(1) Pounds/Ton based upon average 1976 production of 306 tons/day

(2) Flowrate changed considerably due to altered method of determining effluent discharge flow.

(3) Note: Environment Canada published 'expected' loadings from a Kraft mill built in this era are B.O.D.5 99 lbs/ton; Suspended Solids 74 lbs/ton.

6.6 DISSOLVED OXYGEN

In situ dissolved oxygen measurements were taken above and below the pulp mill. A Yellow Springs Instrument Co. - (YSI) - Model 54A dissolved oxygen meter was used for in-field measurements. Water temperature was measured using the dissolved oxygen meter and various scientific thermometers.

Above the mill the water temperature averaged 18°C. Observed dissolved oxygen concentrations averaged 7.6 ppm or 79% saturation; at control stations.

Dissolved Oxygen (D.O.) and temperature measurements were checked by periodically recalibrating the meter and verifying temperature readings.

Dissolved oxygen (D.O.) and water temperature measurements were taken every 2 miles, or at closer intervals; throughout the length of the survey area. The Temperature and D.O. concentrations of both surface water (3 feet from surface) and of the water at a depth equal to ½ the total depth of the water column were measured.

The effect of mill discharges upon dissolved oxygen concentration within the river was quite evident.

As indicated earlier the dissolved oxygen concentration above the pulp mill at Smooth Rock Falls averaged 7.6 ppm or 79% oxygen saturation; this concentration decreased with distance downstream of the pulp mill.

Within the first 8 miles downstream from the mill the dissolved oxygen concentration had slipped to 4.8 ppm or 51% oxygen saturation.

At Mile +8.2 a small riffle area buffered the decline of D.O. concentration for a short reach of the river, however, the oxygen content continued to drop downstream of this point.

The lowest recorded level of dissolved oxygen noted was at Mile +12 where the D.O. sagged to 4.3 ppm or 47% saturation.

At Mile +15 the effect of the Fish Rapids is a very noticeable 'rebound' in the oxygen content of the water. The D.O. rose to 6.3 ppm or 66% saturation immediately below these rapids.

The lasting B.O.D. load placed upon the river is apparent when viewing the continued decline in dissolved oxygen concentration downstream of a substantial re-aeration zone, such as Fish Rapids.

It is noted from observations during this study that the dissolved oxygen concentration resumed a declining trend below Fish Rapids. This decline reached 5.5 ppm or 58% saturation at about Mile +18.

In the portion of the study area between Mile +19 and Mile +26 the river flows through a number of shallow areas and riffle sections. The effect of these physical conditions is to cause a steady recovery of the dissolved oxygen regime within the watercourse. At a point near Mile +23 the dissolved oxygen content had risen to 6.5 ppm or 68% saturation.

Data collected during this study are presented in Table 6.

A graphic illustration of the Dissolved Oxygen Profile of this river, observed during this surveillance; is offered in Figure 5.

TABLE 6

MATTAGAMI RIVER

August 16-17, 1977

Dissolved Oxygen - pH Data

Station #	Location from mill (miles)	Temperature (°C)	Depth Sampled(1) (ft.)	Dissolved Oxygen (2) (mg/l)	Dissolved Oxygen (2) (% saturation)	pH (3)	Comments
1	-4	18.5	3	7.9	83	7.6	Control Station
		18.0	25	7.1	75	7.7	
2	-4	18.3	3	7.85	83	7.7	Control Station
		18.3	10	7.2	76	7.8	
3	-5	18.2	3	7.85	82	7.7	Control Station
		18.2	10	7.90	83	7.8	
5	0	18.8	3	6.4	69	7.6	Mill
		18.5	10	7.3	78	7.7	
6	+2	18.8	3	6.1	66	7.4	
		18.8	11	6.4	69	7.4	
7	+4	18.8	3	5.5	59	7.5	
		18.8	5	6.2	66	7.5	
	+5	18.6	3	5.7	61	-	
		18.6	6	5.7	61	-	

TABLE 6

MATTAGAMI RIVER (Cont'd)

August 16-17, 1977

Dissolved Oxygen - pH Data

Station #	Location from Mill (miles)	Temperature (°C)	Depth Sampled (1) (ft.)	Dissolved Oxygen (2) (mg/l)	(% saturation)	pH (3)	Comments
8	+6	19.0	3	5.0	54	7.5	
		19.0	6	5.2	56	7.6	
	+7	19.2	3	4.8	51	-	
		19.0	10	4.9	53	-	
9	+8	19.0	3	4.8	51	7.7	below small rapids
	+9	19.0	3	4.7	51	-	
		19.0	6	5.2	56	-	
10	+10	19.0	3	4.7	51	7.5	
		19.0	6	5.0	54	7.5	
11	+12	18.8	3	4.3	47	7.4	
		18.5	5	4.9	53	7.4	
	+13	18.0	3	5.5	58	-	
12	+14	18.0	3	5.3	56	7.4	
		18.0	8	5.1	54	7.4	
	+15	18.0	3	6.3	66	-	below Fish Rapids
13	+16	18.3	3	5.9	62	-	
		18.4	5	6.0	63	7.6	

TABLE 6

MATTAGAMI RIVER (cont'd)

August 16-17, 1977

Dissolved Oxygen - pH Data

Station #	Location from Mill (miles)	Temperature (°C)	Depth Sampled (1) (ft.)	Dissolved Oxygen (2) (mg/l)	Dissolved Oxygen (2) (%saturation)	pH (3)	Comments
14	+18	18.3	4	5.5	58	7.5	
	+19	18.3	3	6.2	65	-	below small rapids
15	+20	18.2	4	6.7	70	7.5	
	+21	18.3	3	6.2	65	-	below small rapids
	+22	18.0	3	6.3	66	-	bark accumulation
16	+23	18.2	4	6.5	68	-	largest bark accumulations

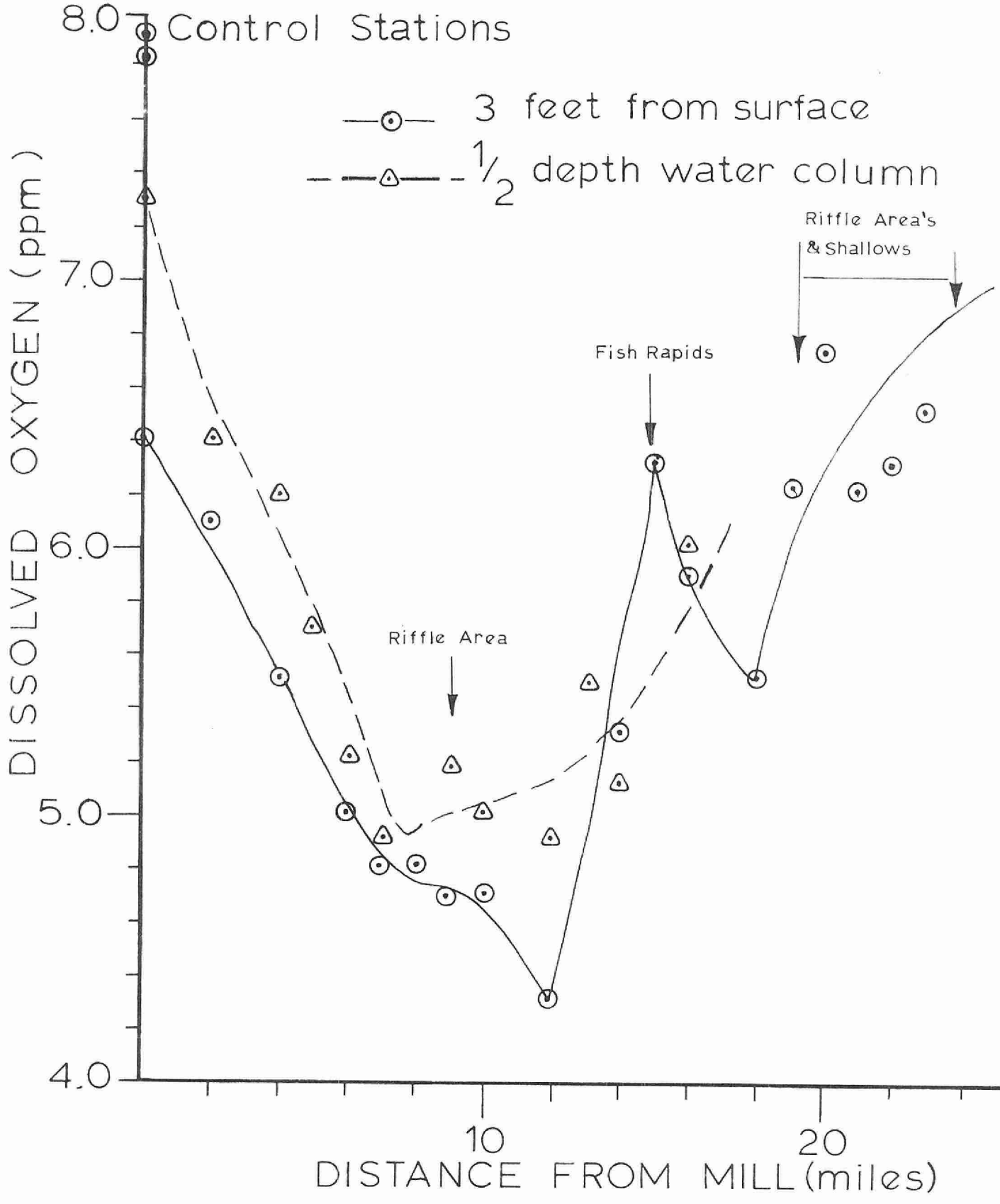
(1) Depth measured on site with weighted marker.

(2) D.O. and Temp. measured with YSl Model 54A Dissolved Oxygen Meter.

(3) pH measured with Radiometer Model pH29 meter.

FIGURE 5

DISSOLVED OXYGEN PROFILE



6.7 pH MEASUREMENT

The pH of river water both above and below the pulp mill at Smooth Rock Falls was observed. Measurements were taken using a Radiometer - Model 29 portable instrument.

Data indicate the ambient pH above the mill to be pH 7.7. Immediately below the pulp mill the pH of the Mattagami River dropped to pH 7.4 - 7.5.

River water pH remained at pH 7.5 throughout the length of the study area. (Table 4)

The discharge from the pulp mill averages pH 5.4 **

**Mill effluent varied from pH 4.4 - pH 7.9 during surveillance. Averaging the Hydronium ion concentrations indicated by measurements of the mill effluent during this study, an average of pH 5.4 was observed. pH swings from pH 3.5 - 10.0 have been observed in the past.

6.8 BASIC WATER CHEMISTRY

During the period August 16-19, 1977, samples of Mattagami River water were collected for analysis. Control stations were established upstream of the pulp mill at Smooth Rock Falls. Samples below the pulp mill were collected from the effluent outlet point to Mile +26 (Poplar Rapids). River water samples were analysed for certain water quality parameters; these being:

- $B.O.D._5$
- C.O.D.
- Dissolved Solids
- Suspended Solids
- Conductivity
- Sodium (Na^+)

As discussed earlier (Ambient Water Quality) the parameters of B.O.D.$_5$; Dissolved Oxygen and Conductivity observed during the August 1977 surveillance compare quite favourably with 'historical' values monitored for the river upstream of Smooth Rock Falls (at Hwy 11) and at Timmins (at Hwy. 101).

One of the primary purposes of this study was to determine various effects upon water quality at Smooth Rock Falls caused by the mill.

The effects of discharges from the mill become apparent when basic water quality data from downstream stations are reviewed.

An indicator of the organic enrichment of a watercourse is the observed concentrations of B.O.D.$_5$ materials above and below a point of emission.

The upstream concentrations of $B.O.D._5$ normally considered the ambient level at Smooth Rock Falls average about 0.8 - 1.4 mg/l.

During the August 1977 work, samples taken upstream of the mill averaged a $B.O.D._5$ concentration of 1.4 mg/l.

A substantial rise in $B.O.D._5$ concentration is noted adjacent the effluent discharge point of the pulp mill. The concentration of $B.O.D._5$ increases from the ambient level (1.4 mg/l) to 4.0 mg/l. The concentration of $B.O.D._5$ decreases to about 1.5 mg/l within 7 miles downstream of the mill. Below the riffle area at Mile +8.2 the observed $B.O.D._5$ concentration increased again. The $B.O.D._5$ level increased to 2.5 mg/l by Mile +12 and remained fairly constant throughout the remaining 14 miles within the study area. (Figure 6; Table 7)

The noticeable dip in B.O.D.$_5$ concentration upstream of the first major riffle area at Mile +8.2 may be indicative of primary dissolved organic components in the effluent from the mill; these materials being readily available for chemical and bacterial oxidation.

At the first riffle area and through subsequent turbulent zones organically enriched sediments may be resuspended, allowing for active sites to be further oxidized.

The observed concentrations in the 2.0-2.5 mg/l range may be a conservative observation of the B.O.D.$_5$ conditions which predominate in the Mattagami River below the pulp mill. The work area extended downstream to the Poplar Rapids, at which point poor access terminated this study. As indicated earlier the reach between Mile +19 and Mile +27 appeared to be a 'settling' zone.

Below this point the rapids may resuspend solids and provide for additional solids transfer for some miles downstream of Poplar Rapids. There may be quiescent zones downstream of Mile +27 where the oxidation of settled solids cause an elevated oxygen demand. Indeed from previous experience when investigating rivers affected by pulp mills the most predominent areas where sediment demands are apparent do not usually occur within the first 25-35 miles of river. This trend has been established for two nearby rivers (Kapuskasing and Abitibi Rivers). (15) It should be noted that this tendency would likely be extended to a point further downstream than 'normally' observed in the case of the Mattagami River; due to the occurrence of several riffle areas and rapids within 25 miles downstream of the pulp mill.

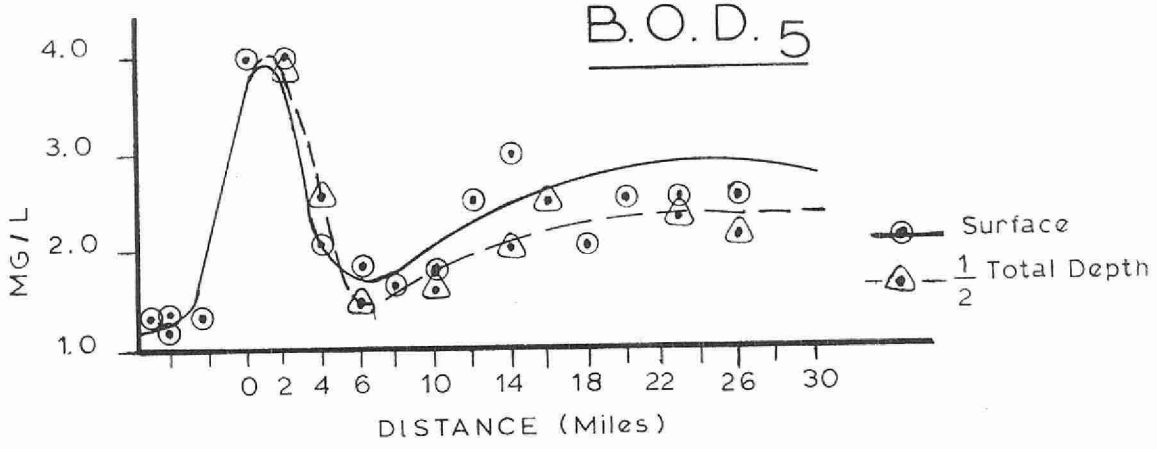
The occurrence of sodium in the mill effluent was used as a means of 'tracing' the effect of these discharges. (Mill effluent averaged 278 mg/l Na^+).

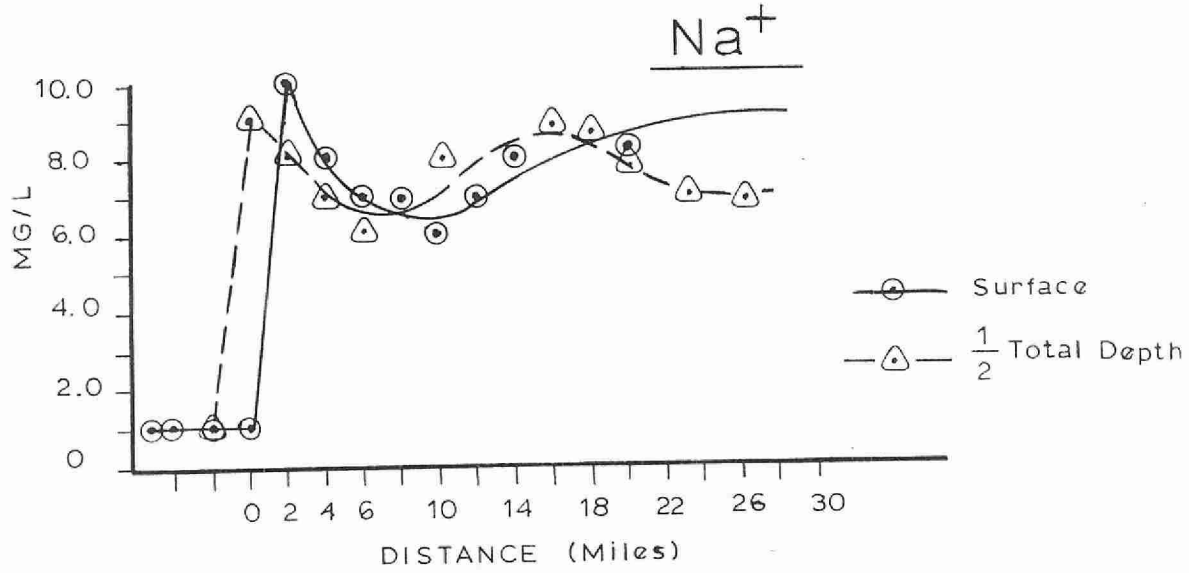
Ambient levels of sodium were 1 mg/l upstream of the mill. This concentration increased to 10 mg/l adjacent the mill. A decrease in sodium concentration was noted above Mile +8.2; at which point the Na^+ concentration rose again to an average level of 8 mg/l. This appears to be the same trend of increased concentration below flow disturbances as suggested for B.O.D.$_5$. (Figure 6; Table 7).

Conductivity measurements are supportive of the Dissolved Solids data already discussed. Ambient conductivity was determined to be 138 uMHO/cm^2. After the entry of the mill discharge this parameter rose to 180 uMHO/cm^2. The conductivity data indicate a decreasing trend downstream of the mill until after the flow disturbances at Mile +8.2. After this point the conductivity rose to level out in the 160-170 uMHO/cm^2 range. (Figure 6; Table 7)

FIGURE 6

MATTAGAMI RIVER - Chemical Data





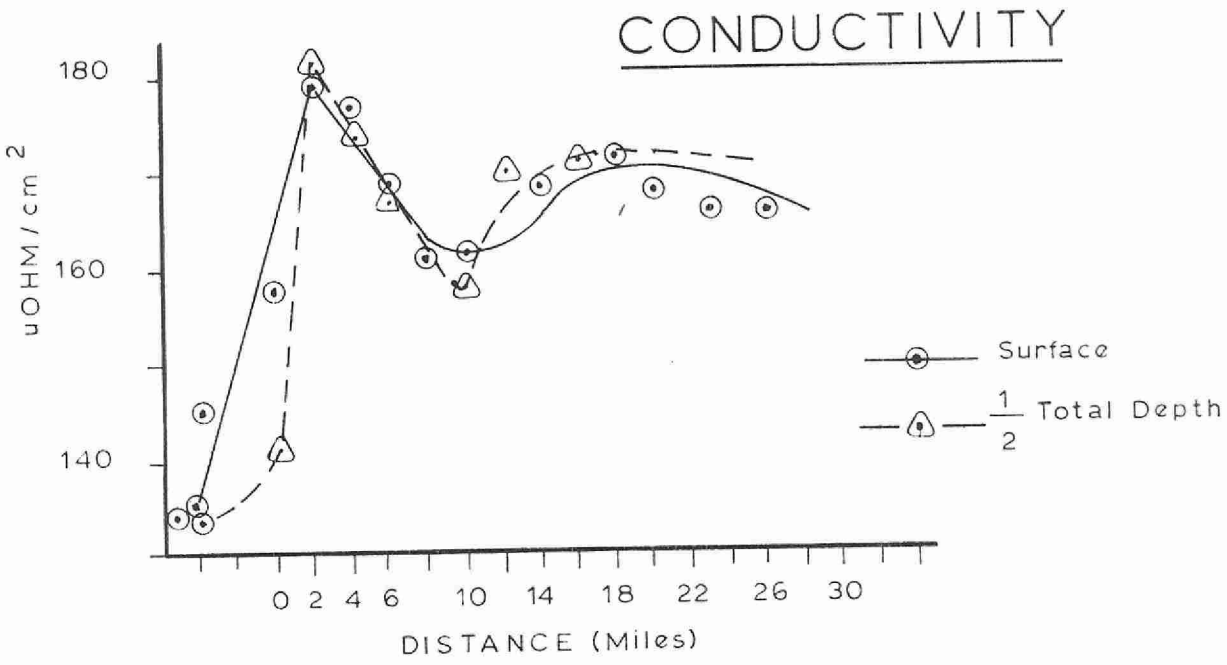


TABLE 7

MATTAGAMI RIVER

August 16-17, 1977

CHEMICAL DATA

Station #	Location from mill (miles)	BOD_5 (mg/l)	COD (mg/l)	SOLIDS DISSOLVED (mg/l)	SOLIDS SUSPENDED (mg/l)	CONDUCTIVITY (uMHO/Cm^2)	Na (mg/l)	COMMENT
1	-4	1.8	34	129	15	145	1	Sampled @ 3 ft.(1)
	-4	1.2	28	130	15	134	1	Sampled @ 20 ft.
2	-4	0.8	28	131	15	135	1	Muskego River
3	-5	1.4	26	124	15	134	1	Sampled @ 3ft.
	-5	1.2	34	124	15	134	1	Sampled @ 20 ft.
5	0	4.0	44	140	15	158	1	Below mill outfall
	0	1.8	31	110	15	141	9	Sampled @ 10 ft.
6	+2	4.0	40	140	15	179	10	Sampled @ 3 ft.
	+2	4.0	46	165	15	181	8	Sampled @ 11 ft.
7	+4	2.0	40	130	15	177	8	Sampled @ 3 ft.
	+4	2.5	33	120	15	173	7	Sampled @ 5 ft.
8	+6	1.8	40	130	15	168	7	Sampled @ 3 ft.
	+6	1.4	40	155	15	167	6	Sampled @ 9 ft.
9	+8	1.6	35	140	15	161	7	Sampled @ 3 ft.
10	+10	1.8	42	125	15	162	6	Sampled @ 3 ft.
	+10	1.6	30	125	15	158	8	Sampled @ 6 ft.
11	+12	2.5	41	145	15	170	7	Sampled @ 6 ft.
12	+14	3.0	35	156	15	169	8	Sampled @ 3 ft.
	+14	2.0	38	147	16	169	8	Sampled @ 8 ft.
13	+16	2.5	41	151	5	170	9	Sampled @ 5 ft.
14	+18	2.0	38	-	5	172	9	Sampled @ 3 ft.
15	+20	2.5	38	-	5	168	8	Sampled @ 3 ft.
16	+23	2.5	35	-	5	166	7	Sampled @ 2 ft.
17	+26	2.5	40	-	5	166	7	Sampled @ 3 ft.
	+26	2.0	31	-	5	165	7	Sampled @ 6 ft.

(1) Depth samples acquired using Van Dorn depth sampler.

6.9 BENTHIC INVERTEBRATE STUDY (16)

During the 1977 survey, bottom samples were collected at selected locations with a Ponar dredge. From 2 to 10 dredges were taken per location, contingent on the degree of difficulty encountered in obtaining representative samples i.e. sampling effort was increased in reaches of the river which were difficult to sample.

The sediments thus collected were visually inspected and their composition recorded. Subsequently, samples were sieved through a 30 mesh-to-inch box screen and the residue was sorted and examined for the presence of aquatic invertebrates. Emphasis was placed on qualitatively evaluating bottom fauna communities, however, general observations on the abundance of representatives of the various taxa were recorded.

Table 8 provides the results of the indentification of bottom fauna from the Mattagami River. Figure 7 depicts the general composition of benthic communities versus distance from the mill at Smooth Rock Falls, based on the data in Table 8.

TABLE 8

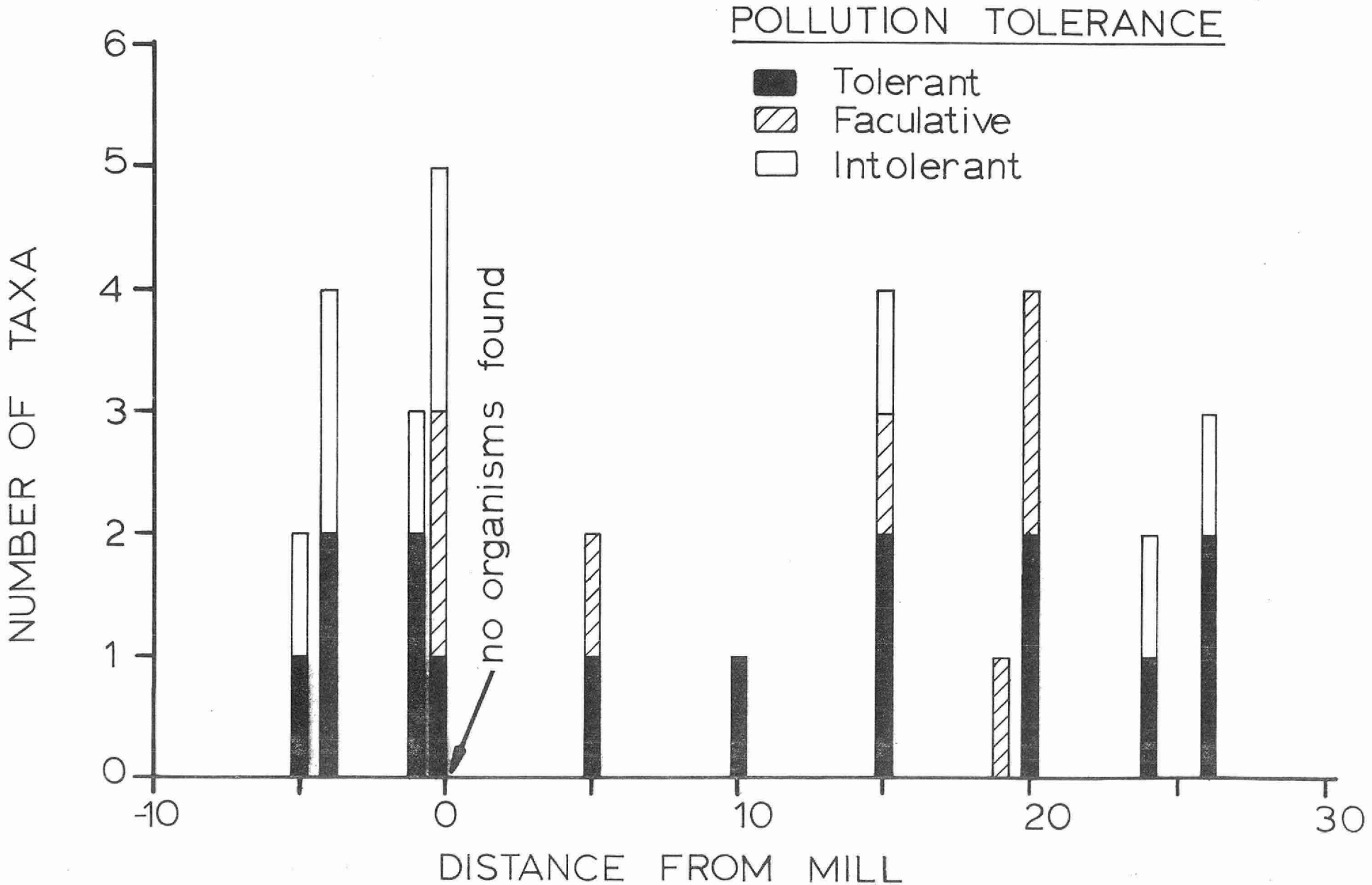
RESULTS OF IDENTIFICATION OF BOTTOM FAUNA

MATTAGAMI RIVER, AUGUST 16 & 17, 1977

TAXA	STATION												
	1	2	3	4A	4B	5	7A	10	12A	14A	15	16A	17
MOLLUSCA													
Gastropoda					X						X		
ANNELIDA													
Oligochaeta	X	X		X			X	X	X		X	X	X
Hirudinea					X		X		X	X	X		
ARTHROPODA													
Crustacea													
Amphipoda					X								
Insecta													
Ephemeroptera													
Ephemeridae	X	X	X										X
Neuroptera													
Sialidae	X	X		X	X				X			X	
Diptera													
Tendipedidae	X	X	X	X	X				X		X		X
Chaoborinidae		X											

X - denotes presence

FIG. 7 BOTTOM FAUNA - MATTAGAMI RIVER



As shown in Figure 7, benthic communities at the reference stations (1, 3, 4A, and 4B) upstream of the input of mill effluent, contained representatives of pollution intolerant taxa (Ephemeridae (Mayflies) and/or Sialidae (Alderflies)) in addition to pollution tolerant and/or facultative forms such as Oligochaeta (worms), Hirudinea (Leeches) and Tendipedidae (Midges). Total number of taxa ranged from 2 to 5. At an additional reference station (not depicted) in the Muskego River (Station 2) community composition was similar to that outlined above for upstream stations in the Mattagami River (see Table 8).

At station 5 (immediately adjacent to the effluent discharge point) sampling efforts yielded no organisms. The elimination of aquatic invertebrate populations at this location may be attributable to toxic conditions induced by the mill effluent or to unsuitable substrate conditions caused by the relatively continuous deposition of fresh fibre and bark deposits. All dredges taken at this site collected large quantities of fresh, undecomposed fibre and bark.

At station 7A (5 miles downstream) some improvement in the benthic population was observed, however, in general, the aquatic community remained very depressed with only 2 taxa, Oligochaeta (pollution tolerant) and Hirudinea (facultative) collected. Severe depression of the benthic community continued at station 10 (10 miles downstream) where only Oligochaeta were found.

Improvement in bottom fauna populations was noted at station 12A (15 miles downstream). At this location, 4 taxa were collected, including representatives of pollution intolerant Sialidae.

At station 14A (19 miles downstream) only Hirudinea were found however the paucity of aquatic invertebrates recorded at this location may be due to the rocky substrate which made dredging difficult, and may not truly reflect actual conditions.

At station 15 (20 miles downstream) 4 taxa were collected however only pollution tolerant and facultative representatives were found. At the succeeding downstream stations; 16A and 17 (24 and 26 miles downstream) numbers of taxa collected

were 2 and 3 respectively and pollution intolerant taxa (Sialidae or Ephemeridae) were present.

In general, it appears that bottom fauna communities have been eliminated adjacent to the mill effluent discharge and that severe depression of aquatic invertebrate populations (based on comparison with communities at locations upstream of the discharge point) exists to at least 10 miles downstream.

At station 12A (15 miles downstream) and at succeeding downstream stations bottom fauna communities showed general improvement both in terms of the numbers and types of taxa present. Benthic communities in this reach of the river approached the general community composition noted at the reference stations (see Figure 8), however, it was observed that individuals of pollution intolerant taxa were significantly more abundant at the reference stations while Oligochaeta (strongly pollution tolerant) were most numerous at downstream locations. This pattern suggests that at least some degree of adverse influence on aquatic biota is exerted to the limit of the present study area

(26 miles downstream). It should be noted that although populations of Oligochaeta showed significant increases at some locations below the point of effluent discharge (particularly areas of bark deposition), numbers of individuals remained relatively low (25 individuals per dredge - estimated) even at stations with large bottom deposits of bark. Populations of this magnitude are much lower than generally observed in cases of severe organic pollution (many hundreds of individuals per dredge). No explanation for this observation is evident although it may be related to the nature of the bottom deposits noted in the Mattagami River i.e.: predominantly bark. This coarse material may be less suitable for Oligochaete colonization than the finer material (fibre) generally abundant in situations of water pollution by pulp and paper mill effluents.

When considering the distribution of invertebrate populations in the Mattagami River it is important to keep the variable nature of the watercourse in mind. The occurrence of riffles and rapids results in large areas of eroding substrate (bare rock bottom) while in relatively quiescent zones

TABLE 9

OBSERVATIONS DURING DREDGING ACTIVITIES,

MATTAGAMI RIVER, AUGUST 16 & 17, 1977

STATION	MILEAGE	COMMENTS
1	-4	- bottom predominantly clay - small proportion of bark (≈10%) - Mattagami River u/s of RR bridge
2	-4	- Muskego River - clay bottom
3	-5	- bottom predominantly clay - small proportion of bark (≈10%)
4A	-1	- at booming grounds, right against log boom - bottom mainly clay with 30-40% bark
4B	-1/10	- immediately below dam (above outfall) - bottom composed of sand, gravel and large pieces of bark.
5	0	- immediately below outfall - bottom covered with very fresh wood fibre (fibre only captured in dredge).
7A	+5	- bottom predominantly rock - pockets of bark and wood chips near banks
10	+10	- rock bottom in centre of river - bottom deposits of bark and chips on sides of river (gas bubbles released on dredge impact).
12A	+15	- just d/s of Fish Rapids - bottom mainly eroding substrate i.e.: bare rocks however some pockets of bark deposits - dredging in areas of bark deposition released gas bubbles
14A	+19	- rocky bottom from bark to bank - only rocks collected in dredge
15	+20	- immediately below riffle area - large bark and fibre accumulation on shore - sampling near bank deposits indicated bottom covered by bark and fibre - remainder of bottom predominantly bare rock with some pockets of coarse sand and bark
16A	+24	- just d/s of large islands - banks lined with chips and bark - bottom covered with bark
17	+26	- banks lined with bark deposits - bottom covered with bark except for a few areas of exposed rock near the bank.

7.0 CONCLUSIONS

Ambient water quality at both Timmins and Smooth Rock Falls (above the pulp mill) are essentially the same.

The effects of log booms on the river, upstream of the Town of Smooth Rock Falls; are causing user/resource conflicts by blocking boat access. The consequences upon water quality, if any, caused by wood floatage have not been investigated adequately to define these effects.

The discharges of pulp mill wastes into the Mattagami River are causing direct effects upon water quality. Specifically the concentrations of Dissolved Oxygen below the mill are severely depressed. Concentrations of $B.O.D._5$, Dissolved Solids, and Sodium increase below the mill. Measurements of conductivity in samples collected during the survey support certain of the chemical data presented. A slight pH depression below the pulp mill was observed.

The study performed in August 1977 indicates that

a major settling zone occurs in the area of Mile +26. Past experience suggests that other settling zones; with subsequent degraded water quality, likely exist downstream of this point. Access on the river below Poplar Rapids (Mile +27) is difficult.

Consideration should be given to performing a more comprehensive water quality/biological study on the Mattagami River. This survey should include the entire length of the river from Smooth Rock Falls to the Little Long Reservoir.

8.0 APPENDIX I

THE EFFECTS OF PULP MILL WASTES UPON RECEIVING WATERS

8.1 THE EFFECTS OF PULP MILL WASTES UPON RECEIVING WATERS

The most significant effects caused by discharges into the aquatic environment from the pulp and paper industry are the depletion of dissolved oxygen concentrations and the increase in suspended solids levels within the receiving streams.

'Adequate dissolved oxygen levels are essential to sustain fish and other aquatic life. For fish, dissolved oxygen requirements must satisfactorily provide for egg development; for the newly hatched young; and for normal growth and development through the later life stages. Field studies have shown that good and diversified warm water fish populations can occur in water in which the dissolved oxygen level is between 5 and 6 mg/l during the summer months. If the dissolved oxygen is never less than 5 mg/l, a healthy fish population will be assured'. (3)

Organic wastes; such as pulp mill waste liquors and fibrous material; such as bark fines, slivers, fiber; decompose due to chemical and

bacterial action. As these materials decompose they exert a demand or 'need' for the dissolved oxygen present in the receiving waters. Bark and fibrous materials contribute significantly to the absolute bio-chemical oxygen demand (B.O.D.) of pulp mill wastes. These solid particles decompose very slowly, exerting a lasting influence upon the oxygen demands of the watercourse.

Various investigators have also noted physical damage to gill tissues in fish caused by excessive levels of suspended solids in the aquatic environment of these animals. (4)

Professor H.B.N. Hynes of the University of Waterloo suggests "sewage (human), of course, is well innoculated with bacteria and is adequately supplied with bacteria and with a wide range of compounds, so it gets broken down relatively easily. But some materials, notably wood pulp, are very poor bacterial foods and are decomposed very slowly. They therefore exert a lower oxygen demand, but for a long time; which in aggregate

may be very great. Paul (1952) quotes a figure of 1,300,000 ppm for sawdust; for untreated sewage (human) this figure is about 600 ppm". (5)

Kraft pulp mills have also been determined by various investigators to be dischargers of toxic substances. These studies prompted the Federal Ministry of the Environment to include fish toxicity requirements in their Regulations (6) (7).

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